Claims

[c1] 1.An internal combustion engine having a combustion chamber, at least one gas flow passage communicating with said combustion chamber through a valve seat, a poppet valve for controlling the flow through said valve seat, a camshaft journalled for rotation about a camshaft axis, a first cam having a first lift characteristic fixed for rotation with said camshaft, a second cam associated with said camshaft for relative rotation, said second cam has a second lift characteristic different from said first lift characteristic of said first cam, a valve actuator associated with said first and said second cams for transmitting their rotational movements to reciprocation of said poppet valve, and a coupling device for selectively permitting relative movement between said camshaft and said second cam so that said first cam controls the entire opening and closing cycle of said poppet valve and for coupling said second cam for rotation with said camshaft about said camshaft axis so that said second cam controls at least a part of the opening and closing cycle of said poppet valve.

[c2] 2.An internal combustion engine as set forth in claim 1 wherein the coupling device maintains the angular phase positions of the first and second cams regardless of which cam is controlling the opening and closing cycle of the poppet valve.

[c3] 3.An internal combustion engine as set forth in claim 1 wherein the maximum valve lift provided by the second cam is greater than that of the first cam.

[c4] 4.An internal combustion engine as set forth in claim 3 wherein the coupling device maintains the angular phase positions of the first and second cams regardless of which cam is controlling the opening and closing cycle of the poppet valve.

[c5] 5.An internal combustion engine as set forth in claim 4 wherein the coupling device shifts the axis about which the second cam rotates when the first cam controls the entire opening and closing cycle of the poppet valve so that the

second cam does not control the opening and closing cycle of said poppet valve.

[c6] 6.An internal combustion engine as set forth in claim 1 wherein the coupling device comprises an eccentric bushing having a cylindrical bore coaxially received on the camshaft and an cylindrical outer surface eccentrically disposed to said cylindrical bore and received in a complimentary bore formed in the second cam and a selectively operable lock for coupling one of said eccentric bushing and said second cam for rotation with said camshaft so that both said second cam and said eccentric bushing rotate in unison with said camshaft.

[c7] 7.An internal combustion engine as set forth in claim 6 wherein the selectively operable lock fixes the second cam for rotation with the camshaft.

[c8] 8.An internal combustion engine as set forth in claim 6 wherein the coupling device further maintains the angular phase positions of the first and second cams regardless of which cam is controlling the opening and closing cycle of the poppet valve.

[c9] 9.An internal combustion engine as set forth in claim 8 wherein the portion of the coupling device that maintains the angular phase positions of the first and second cams regardless of which cam is controlling the opening and closing cycle of the poppet valve comprises a resiliently biased member engaged between the camshaft and said second cam.

[c10] 10.An internal combustion engine as set forth in claim 9 wherein the selectively operable lock is operative to axially limit the movement of the eccentric bushing relative to the camshaft in at least one axial direction.

[c11] 11.An internal combustion engine as set forth in claim 10 wherein the resiliently biased member is operative to axially limit the movement of the eccentric bushing relative to the camshaft in an axial direction opposite to the axial direction controlled by the selectively operable lock.

[c12] 12.An internal combustion engine as set forth in claim 6 wherein the selectively operable lock is operative to axially limit the movement of the eccentric bushing relative to the camshaft in at least one axial direction.

[c13] 13.An internal combustion engine as set forth in claim 1 wherein the first cam and the second cam are juxtaposed axially on the camshaft.

[c14] 14.An internal combustion engine as set forth in claim 6 wherein the first cam and the second cam engage adjacent surfaces of a common follower for transmitting their rotational movements to reciprocation of said poppet valve.

[c15] 15. An internal combustion engine as set forth in claim 1 further including a second poppet valve for opening and closing a second valve seat in the combustion chamber and a third cam and wherein the cams are juxtaposed axially on the camshaft and one of said first and said second cams has cam portions for controlling the opening and closing cycle of both of said poppet valves, the other of said first and second cams controlling the opening and closing cycle of only one of said poppet valves and said third cam controls at least a portion of the opening and closing cycle of the other of said poppet valves.

[c16] 16.An internal combustion engine as set forth in claim 15 wherein the cam having the cam portions for controlling the opening and closing cycle of both of the poppet valves comprises the second cam.

[c17] 17.An internal combustion engine as set forth in claim 16 wherein the coupling device comprises an eccentric bushing having a cylindrical bore coaxially received on the camshaft and an cylindrical outer surface eccentrically disposed to said cylindrical bore and received in a complimentary bore formed in the second cam and a selectively operable lock for coupling one of said eccentric bushing and said second cam for rotation with said camshaft so that both said second cam and said eccentric bushing rotate in unison with said camshaft.

[c18] 18.An internal combustion engine as set forth in claim 17 wherein the selectively operable lock fixes the second cam for rotation with the camshaft.

[c19] 19.An internal combustion engine as set forth in claim 18 wherein the coupling device further maintains the angular phase positions of the first and second cams regardless of which cam is controlling the opening and closing cycle of the poppet valve.

[c20] 20.An internal combustion engine as set forth in claim 19 wherein the portion of the coupling device that maintains the angular phase positions of the first and second cams regardless of which cam is controlling the opening and closing cycle of the poppet valve comprises a resiliently biased member engaged between the camshaft and said second cam.

[c21] 21.An internal combustion engine as set forth in claim 19 wherein the selectively operable lock is operative to axially limit the movement of the eccentric bushing relative to the camshaft in at least one axial direction.

[c22] 22.An internal combustion engine as set forth in claim 21 wherein the resiliently biased member is operative to axially limit the movement of the eccentric bushing relative to the camshaft in an axial direction opposite to the axial direction controlled by the selectively operable lock.